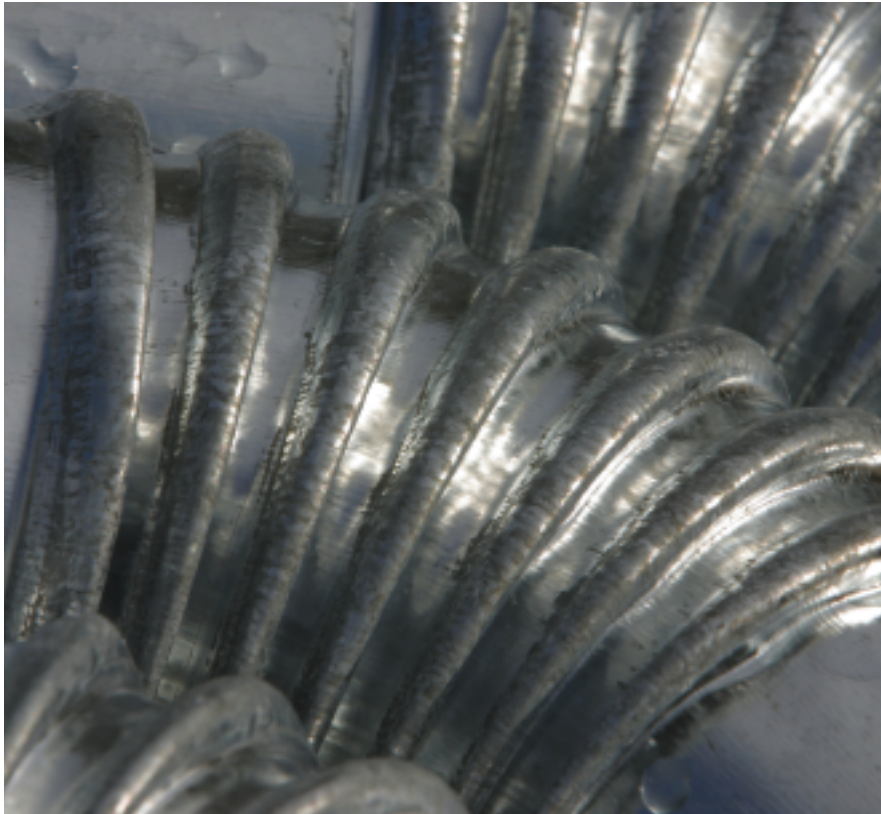


ALLERGEN Focus



Focus on T.R.U.E. Test Allergen #4: Chromates

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The thin-layer rapid use epicutaneous (T.R.U.E.) test of 23 common allergens is a valuable, first-line screening tool used by many dermatologists. Although the test focuses on common allergens, frequent questions have arisen from colleagues and patients as to where a specific allergen is derived or what products patients should avoid. With this in mind, this column was developed to provide educational information about the T.R.U.E. test allergens.

A rich, interesting history accompanies each of the 23 allergens, and understanding these historic perspectives can help to better educate patients. Each column will also highlight appropriate products that patients should avoid when they are allergic to a specific allergen.

CONTACT DERMATIDES

Allergic contact dermatitis is an important disease with high impact both in terms of patient morbidity and economics. The contact dermatides include irritant contact dermatitis, contact urticaria and allergic contact dermatitis.

Irritant contact dermatitis, the most common form, accounts for approximately 80% of environmental/occupational-based dermatoses.

Contact urticaria (wheal and flare reaction) represents an IgE and mast cell-mediated immediate-type hypersensitivity reaction that can lead to anaphylaxis; the foremost example of this would be latex protein hypersensitivity.

While this is beyond the scope of this section, we acknowledge this form of hypersensitivity due to the severity of the potential reactions and direct the reader to key sources.^{1,2}

Allergic contact dermatitis, on the other hand, is a delayed type IV hypersensitivity reaction that has high impact both in terms of patient morbidity and economics. The primary focus of this section is to highlight the educational component of allergic contact dermatitis.

CLINICAL ILLUSTRATION

We report a case of a female patient with a known allergy to costume jewelry and a worsening dermatitis on her neck who presented to the Contact Dermatitis Clinic at the University of Miami for evaluation. She had been told she probably had an allergy to nickel, but she wanted to have this confirmed by a definitive test.

THE HISTORY OF CHROMIUM

In 1761, J.G. Lehmann found an orange-red mineral in the Ural Mountains, which he named “Siberian red lead”; this material was in fact lead chromate ($PbCrO_4$, crocoite). It wasn’t for another 37 years until the French chemist L. N. Vauquelin isolated elemental chromium from the crocoite mineral.³ This same chemist, through the analysis of a Peruvian emerald, discovered that the gem’s green color was a result of the presence of this new element.

Chromium is a blue-white metal that is hard, brittle and very resistant to corrosion. The sixth most abundant element

TABLE 1

CHROMIUM COMPOUNDS & INDUSTRY ^{8,15}**AUTOMOTIVE INDUSTRY**

Zinc Chromate (Primer Paints)

EXPLOSIVES

Chromic Nitrate

MAGNETIC TAPES

Chromium Dioxide

MILK TESTING LABORATORIES

Potassium Dichromate

PHOTOGRAPHYSodium and Potassium Dichromate
Chromium Phosphate Chromate**RAILROAD INDUSTRY (DIESEL LOCOMOTIVE)**

Sodium Dichromate

SURGICAL SUTURESAmmonium Dichromate (Catgut)
Potassium Dichromate (Silk)**LEATHER TANNERY**Chromic Acid
Chromium Potassium Sulfate**TV COLOR SCREENS**

Ammonium Dichromate

WELDING INDUSTRY

Chromium Oxide

WOODWORKERS

Chromated Zinc Chloride

in the earth's crust,³ and is found in combination with other elements (only meteorites contain free chromium).³ The name chromium was derived from the Greek word "chroma", which means color in reference to the many colored compounds displayed by it.

Chromium is mined as chromite (FeCr₂O₄) ore. Roughly half the world's chromite is found in southern Africa (mainly Zimbabwe). An estimated 15 million tons of marketable chromite ore were produced in 2003.⁴

HOW CHROMIUM IS USED

Chromium has many uses, which have evolved over the years. During the 1800s, chromium was primarily used as a component of paints, but now the metallurgical industry uses about 91% of the chromium consumed in the United States. The remaining 5% and 4% is con-

sumed by the chemical and refractory industries, respectively.⁴

In many countries, chromium is a major ingredient in cement, which has resulted in cement exposure as a major cause of ACD. Construction workers and bricklayers have an increased risk of developing chromium allergy.⁵

During cement manufacture, hexavalent chromium (Cr₆) is formed from the trivalent chromium (Cr₃) present in the raw material from which cement is produced. Hexavalent chromium better penetrates and accumulates in the skin than its trivalent counterpart. Cr₆, and to a much lesser extent Cr₃, are sensitizing agents capable of producing ACD.³

Since 1981, Denmark (and subsequently other European countries) has added ferrous sulfate to cement, a process that reduces Cr₆ to Cr₃, effectively decreasing allergic potential.⁵ With the reduction in allergy from cement, leather shoe products have become an important source of chromium exposure and subsequent allergy in those countries.⁵

Currently, no requirements exist to mandate that U.S. cement contain ferrous sulfate. Additionally, there's financial resistance to changing the way cement is made in the United States. The cost of U.S. cement would escalate with the addition of ferrous sulfate and cause the current chromium material consumption to exceed the current \$264 million a year.⁶

Second, when ferrous sulfate is added and the cement isn't used soon (prevalent in the United States due to extended transport times), spontaneous oxidation and inactivation of the ferrous ion occurs.

Last, concerns exist about possible effects on the structural integrity of finished concrete (durability problems).⁷

As early as 1820, with potassium dichromate being widely used as a mordant (fixing agent) in dyed textiles, skin reactions to chrome became apparent.⁸

In 1925, Dr. Parkhurst first reported a positive chromium patch test in a blueprints processor. Since then, chromium allergy cases have surfaced, ranging from occupational contact in a lithographer (1931); an aircraft mechanic during World War II; cement workers (1950); and in magnetic tape handlers and cellular phone workers, 1977 and 2003, respectively.^{8,9}

TABLE 2

FOODS HIGH IN CHROMIUM ^{3,15}

Apple Peel

Beer (Brewer's Yeast)*

Black Pepper*

Broccoli

Canned Fruits* (Plums)

Chicken Eggs*

Cloves*

Frozen or Canned Vegetables* (Frozen Peas)

Green Beans

High-Bran Cereals

Processed Meats* (Beef)

Mushrooms

Onions

Potatoes

Seafood* (Oysters, Mussels, Clams, Cockles)

Thyme*

*May contain up to 200 mcg Cr/kg

Of interest, inhabitants of billiard houses, such as professional gamblers, roulette buffs and card players, were particularly at risk for what is known as "Blackjack Disease". This is a dermatitis caused by exposure to chromium salts used for dyeing the green felt that covers the gambling tables.¹⁰

The industrial uses for chromium are quite extensive, in addition to the aforementioned utilities. Chromium is also used in anti-corrosives, chrome plating (decorative and hard plating), ceramics, explosives, wood preservatives, and pigments (paints, varnishes).³ Additional uses for chromium vary widely from suture materials (chromated catgut), shaving cream (chromic acid may be added to prevent rusting of razor blades), cosmetics, green tattoos, acupuncture needles (Cr content 18.12%), medical prosthetics such as artificial knees and hips (which may contain up to 20% Cr) and metal wire in orthodontic materials.¹¹⁻¹⁴

Food and smoking are other significant sources of chromium exposure. The amount of chromium in the U.S. diet ranges from 25 to 224 mcg/d (mean 60 to 79 mcg/d).³ Notably, multivitamins on average contain 15 to 200 mcg.

Chromium levels are higher in canned foods stored in unlacquered welded cans than lacquered welded cans.¹⁶ In this same way, chromium has been reported to leach into wines from green colored

bottles,⁴ and during storage in stainless steel tanks.⁴

Concentrations of chromium in tobacco range from 0.24 to 14.6 mg/kg, but the amount of chromium absorbed into the body as a result of smoking is not known.³

Clinically, reactions to chromates tend to be insidious, persistent and relapsing.¹⁵ Once chromate sensitivity has been established, the dermatitis tends to become more severe, more extensive, and takes longer to clear with each exposure.¹⁵ Therefore, patients have a greater tendency toward dryness, fissuring and lichenification.¹⁵ The valence and amount of chromium (dose) are important factors for sensitization development.

The interplay between mankind's industrialization and planetary balance is seen in increased exposure to chromium.

In urban areas, the chromium content in the air average 0.01 to 0.03 mcg/m³, with fuel combustion and metal production as leading sources.

Very high concentrations of chromium in soil may result from the deposition of chromium-containing commercial products in areas such as landfills.³

In U.S. drinking water, the mean value concentration of chromium is 1.8 mcg/L (average 0.4 to 8 mcg/L), which is about six-fold higher than the mean chromium level in sea water. In this being said, the major source of chromium in aquatic systems is domestic wastewater effluents.³

TESTING FOR CHROMATE SENSITIVITY

Patch testing for chromate allergy can be accomplished with the T.R.U.E. test [site # 4]. The T.R.U.E. test recognizes only 23 of the more than 3,700 possible allergens that can cause allergic contact dermatitis. Therefore, it needs to be known that this test is a mere screening tool that could be used by general dermatologists everywhere.

Unfortunately, we are faced with important workforce economics. There are roughly 14,500 U.S. members of the American Academy of Dermatology, and many of these dermatologists serve remote locations. In contrast, there are approximately 450 members of the Allergic Contact Dermatitis Society (www.contactderm.org). This translates



An allergic reaction to chromate. This type of allergy is often persistent and relapsing.

to one comprehensive patch tester to every 33 dermatologists, if the distribution was evenly cast, which is not the case. So, in geographic areas with limited access, the T.R.U.E. test should be recognized and utilized as a basic, necessary screening tool and its limitations understood.

The American Contact Dermatitis Society (ACDS) recognizes the need for comprehensive patch testing support. The ACDS is actively engaged in maintaining access to this important testing modality by training new providers (ACDS-Fujisawa mentorship program) and providing patient education materials through the Contact Allergen Replacement Database (CARD).

THE VALUE OF THIS PATIENT CASE

Our patient with allergy to chromates underscores the importance of appropriate patch testing and subsequent patient education.

The presence of chromates in such a wide variety of products makes it an especially common, difficult to avoid, contactant in daily activities.

The patient began a chromium restriction regimen, which included discontinuing leather goods, costume jewelry, and multi-vitamins. With this, the patient dramatically improved, consistent with the fact that the mainstay of treatment for allergic contact dermatitis is avoidance. ■

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